RETURNS OF HATCHERY-REARED LAKE TROUT FROM EIGHT LAKES IN NORTHEASTERN ONTARIO

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ABSTRACT

Powell, M.J., M.-F. Bernier, S.J. Kerr, G. Leering, M. Miller, W. Samis, and M. Pellegrini. 1986. Returns of hatchery-reared lake trout from eight lakes in northeastern Ontario. Ont. Fish. Tech. Rep. Ser. No. 22: iii & 7 p.

Eight lakes in northeastern Ontario were stocked with 16 month old lake trout (18.6 - 24.3 g) in 1977, 1979, 1980 and 1981. The contribution of hatchery lake trout to the size of the naturally produced year-classes, as assessed by gill nets from 1980 to 1983, ranged from 1% in Net Lake to 92% in Shakwa Lake. In four of the lakes, the stocked fish outnumbered the native fish in the year-classes considered. The survival of the hatchery fish seemed to be negatively influenced by both the size of the native lake trout population in the lake and the size of the whitefish and cisco populations.

Keywords: lake trout, stocked fish, survival.

RETURNS OF HATCHERY-REARED LAKE TROUT FROM EIGHT LAKES IN NORTHEASTERN ONTARIO

INTRODUCTION

In northeastern Ontario a common management practice for lakes containing resident lake trout (*Salvelinus namaycush*) populations has been the stocking of hatchery-reared lake trout. The survival rate of stocked fish has, for the most part, been rather poorly documented. Where studies have been done, however, results have indicated that survival may be negatively influenced by the size of the natural lake trout population (Purych 1977); positively related to the size at stocking (Pycha and King 1967); or dependent on the strain of lake trout being stocked (Plosila 1977).

It was generally held by fisheries managers in the Northeastern Region that survival of lake trout planted at a size of <10 g was quite poor. Consequently, a program was initiated to examine the success of stocking larger lake trout (>18 g) of one strain into lakes which were subjectively evaluated as having poor, intermediate and excellent native lake trout populations. Although the concern that precipitated the study was the apparent poor survival of small hatchery lake trout, the experimental design was not appropriate for a comparison of the survival of small versus large trout. This paper is therefore limited to documenting the contribution of stocked lake trout to the existing lake trout populations, and suggesting some of the variables which may have affected the survival of the stocked trout.

METHODS

The lakes selected for the stocking assessment program are all deep, cold lakes with low total dissolved solids. Physical and chemical data for the 8 lakes are presented in Table 1. Prior to the study, Shakwa and Rushbrook were subjectively evaluated as having excellent native lake trout populations. North Anvil, South Anvil and Wawa lakes were considered to have fair native lake trout populations and Peshu, Net and Mount were assessed as having poor native lake trout populations.

Lake trout stocking was to begin in 1977 and continue for three consecutive years, however, a disease outbreak at the North Bay Hatchery resulted in a shutdown of the facility in 1978. The program was begun again in 1979 with stocking occurring in 1979, 1980 and 1981. All stock originated from Lake Manitou, a hardwater lake situated on Manitoulin Island. Eggs were incubated to the eyed stage at Sandfield Fish Culture Station and then transferred to the North Bay Fish Culture Station where they were raised until 16 months old. Immediately prior to stocking a random sample of 50 lake trout were weighed and measured. The trout were then stocked into all the study lakes except Mount Lake at a rate of approximately 12.4 fish ha^{-1}. An error in the estimation of the surface area of this lake resulted in a stocking rate of 7.5 fish ha^{-1} in 1979, 1980 and 1981. Mount Lake was a late addition to the study lakes and was not considered to be part of the program in 1977. In that year, Mount Lake was stocked at a rate of 16.1 fish ha^{-1} with the same lot of fish as the other 7 study lakes. A stocking history for the 8 lakes from 1970 to 1981 is summarized in Table 2.

Table 1. Physical and chemical data for study lakes.

	Wawa	North Anvil	South Anvil	Peshu	Mount	Shakwa	Rush-brook	Net
Area (ha)	678	92	74	389	345	649	174	711
Volume ($x10^6$ m^3)	10559	639	526	6984	1473	6264	1263	5965
Secchi (m)	9.3	3.8	5.6	6.1	4.5	6.0	5.3	5.0
Mean depth (m)	15.6	7.0	7.0	18.0	4.2	9.7	7.3	8.4
Max. depth (m)	32.9	18.3	31.1	50.0	29.9	27.4	19.2	47.6
*TDS (mg l^{-1})	106	20	18	29	27	23	28	51
*MEI (metric)	6.8	2.9	2.6	1.6	6.4	2.4	3.8	6.1

*TDS = Total dissolved solids.
*MEI = Morphoedaphic index.

Table 2. Lake trout stocking history for study lakes.

Year	Wawa	North Anvil	South Anvil	Peshu	Mount	Shakwa	Rush-brook	Net	Fork length (cm)	Weight (g)
1970	6000 fg	2000 LP	2000 LP	7000 LP		5000 LP	2500 LP	4500 LP		
1971	6000				5000 RP	3000 RP	2000 RP			
1972		2000 RV	2000 RV	7000 RV		4000 RV	2000 RV	4500 RV		
1973					5000 A	3000 A	2000 A	5000 A		
1974		2000 LV	2000 LV	7000 LV		2300 LV	2000 LV	3150 LV		
1975					5000 LP	2000 LV+A	1500 LV+A			
1976				7000 A		2000 A	1500 A	6000 A		
1977	8382 A	1140 A	920 A	4796 A	5540 A	8020 A	2150 A	8986 A	-	20.6
1979	8376 A	1100 A	1000 A	4800 A	2580 A	8010 A	2150 A	8996 A	12.5	18.6
1980	8363 A	1070 A	1000 A	4795 A	2584 A	8010 A	2150 A	9000 A	13.6	24.3
1981	8366 A	1149 A	951 A	4794 A	2585 A	8010 A	2142 A	9000 A	12.6	19.0

Fin clips - A = adipose, RV = right ventral, LV = left ventral, RP = right pectoral, LP = left pectoral, fg = fingerling.

North Anvil, South Anvil, Shakwa, and Rushbrook lakes were all stocked by airplane which landed on each lake and distributed the fish over deep water some distance from shore. Peshu Lake was stocked from shore in an area which dropped steeply to 12-15 m. Stocking in Wawa Lake took place in 1-5 m of water over rock and rubble at 4 different locations and was done from shore and by boat. Mount Lake was stocked from a boat over water of approximately 10 m in depth and Net Lake was stocked from a boat over rock shoals.

All fish were marked with an adipose fin clip prior to stocking. The same clip was used each year in order to eliminate any effect that differential clipping might have on survival. Lake trout captured during the subsequent assessment phase of the program were separated into cohorts by scale aging which was felt to be reasonably accurate for younger fish.

An assessment of stocking success was done by extensively gill netting 7 of the 8 lakes during August or September of 1980, 1981, 1982 and 1983. Net Lake was fished only during 1982 and 1983. One gang of nets consisted of 4 panels of monofilament nylon net of each of the following mesh sizes (stretched measure): 2.5 cm, 3.8 cm, 5.1 cm and 6.4 cm. Each panel was 2.4 m deep by 15.2 m long. All net sets were kept as close to 24 hours as possible.

The target on each lake was to capture 50 lake trout less than 30 cm in each year or, if this target could not be met, to set at least 10 gangs of nets. Nets were not set at random sites throughout the lake, since the primary objective was to capture small lake trout and observe the ratio of clipped to unclipped fish. Nets which produced catches of small trout were often reset and netting locations were often repeated in subsequent years. All lake trout captured were weighed, measured, examined for clips and a scale sample was taken for later age determination. Any trout that was judged to be capable of surviving after being netted was returned to the water. All other trout were examined for stomach contents. In most instances, species other than lake trout were merely recorded as being caught and returned to the water. Condition factors were calculated for individual trout by using the formula $C = W/FL^3 \times 10^5$ where W is the weight in g and FL is the fork length in mm.

Measurements of dissolved oxygen, pH, alkalinity, temperature and conductivity were made during each netting session to determine if water quality remained suitable for lake trout in all lakes throughout the study.

RESULTS

The average catch-per-overnight-net-set (CUE) over the 4 years of the study is presented in Table 3. The number of overnight sets in each lake in each year is also given.

The mean CUE of hatchery and native lake trout combined ranged from 1.83 in Rushbrook Lake to 11.51 in Net Lake. Other coldwater species inhabiting the lakes included lake whitefish (*Coregonus clupeaformis*) in 6 of the lakes, round whitefish (*Prosopium cylindraceum*) in 2 of the lakes, burbot (*Lota lota*) in 5 of the lakes, and cisco (*Coregonus artedii*) in 2 lakes. Wawa Lake was the only lake of the group which contained rainbow smelt (*Osmerus mordax*). Some species other than those listed in Table 3 are present in the lakes but were not captured by the nets which were targeted for

Table 3. Catch-per-overnight-net-set for study lakes, 1980-83.

Species	Wawa	North Anvil	South Anvil	Peshu	Mount	Shakwa	Rush-brook	Net
Lake trout (*Salvelinus namaycush*)	3.80	5.51	4.24	3.53	3.90	4.30	1.83	11.51
Lake whitefish (*Coregonus clupeaformis*)	19.57			18.45	24.30	11.38	8.28	2.59
Round whitefish (*Prosopium cylindraceum*)		16.60	15.50					
Burbot (*Lota lota*)	0.66			0.05	1.01	0.08		0.20
Sculpin (*Cottus* sp.)	0.04				0.02			
Lake chub (*Couesius plumbeus*)	4.23	3.18	7.41				0.04	
Rainbow smelt (*Osmerus mordax*)	5.15							
Sucker (*Catostomus* sp.)	0.62	38.56	21.56	0.02	0.06	2.85	3.50	
Cisco (*Coregonus artedii*)	5.48							41.25
Golden shiner (*Notemigonus crysoleucas*)		0.06						
Common shiner (*Notropis cornutus*)		1.37	0.11			0.02	0.10	
Yellow perch (*Perca flavescens*)						0.50	16.36	
Pearl dace (*Semotilus margarita*)		0.56	0.08				0.02	
Creek chub (*Semotilus atromaculatus*)		0.56						
Brook trout (*Salvelinus fontinalis*)		0.02	0.02				0.02	
Rainbow trout (*Salmo gairdneri*)	0.03							
Total for all species	39.58	66.42	48.92	22.05	29.29	19.13	30.15	55.55
Number of overnight net sets - 1980	20	12	10	36	20	19	20	-
1981	20	14	12	24	24	19	16	-
1982	19	12	12	32	16	13	20	8
1983	20	12	12	26	24	11	12	4

small lake trout. Water chemistry completed at the time of netting indicated low oxygen levels below the thermocline in Rushbrook Lake. The oxygen deficiency restricted the lake trout to a 2 m band of water during the late summer and fall of each year. No adverse conditions were noted in any of the other lakes throughout the study.

Table 4 shows the mean fork length of lake trout taken during the 4 years of netting.

Trout up to 10+ were taken in some lakes, however, sample sizes after age 7+ were very small and accurate aging was questionable. Table 4 combines native and stocked trout although there is some evidence that the stocked trout were larger than the native trout in the younger age groups. In all lakes age 1+, 2+ and 3+ stocked trout were slightly larger than the native fish, although the difference was not statistically significant ($p > .05$) in any of the lakes.

Table 4. Mean fork lengths of lake trout taken during 4 years of netting, 1980-83 (native and stocked fish combined).

Age	Wawa	North Anvil	South Anvil	Peshu	Mount	Shakwa	Rush-brook	Net*
1	15.2 (6)**	-	14.1 (8)	14.5 (19)	14.4 (26)	15.7 (17)	14.1 (12)	14.2 (2)
2	19.5 (44)	19.7 (20)	20.7 (27)	19.6 (53)	19.4 (93)	20.6 (74)	19.9 (40)	17.8 (13)
3	26.3 (100)	26.3 (57)	28.1 (43)	24.7 (99)	24.5 (99)	28.6 (80)	27.1 (6)	24.3 (41)
4	30.8 (70)	30.3 (30)	33.3 (20)	30.3 (141)	30.2 (38)	33.4 (24)	29.1 (23)	27.7 (31)
5	39.4 (25)	36.9 (63)	38.2 (18)	35.7 (36)	34.3 (14)	42.9 (15)	40.7 (7)	33.6 (18)
6	45.5 (10)	43.2 (29)	45.3 (10)	44.1 (6)	41.8 (3)	56.7 (8)	46.2 (4)	41.8 (7)
7	53.3 (27)	48.3 (20)	50.5 (14)	51.5 (5)	51.4 (5)	-	51.5 (3)	-

* Net Lake was netted in 1982 and 1983 only.
** Number in brackets indicates sample size.

The contribution of stocked fish to year-class strength in the 8 lakes is shown in Table 5. The table includes only trout up to age 5, as sample size decreases rapidly after this age and errors in aging increase. Age 1+ trout were excluded from the analysis because of indications that the stocked fish were larger than the native fish and perhaps, more vulnerable to capture. Reversals in the ratio of stocked to native fish were apparent between age 1+ and 2+ fish of the 1979 year-class in Mount Lake and the 1979 and 1980 year-classes in Peshu Lake. This is probably due to the stocked fish being more vulnerable to the capture gear at age 1+ because of their larger size.

To gain some insight into the mechanisms which might influence stocking success a correlation matrix was constructed using the CUE of stocked lake trout, CUE of native lake trout, condition factor, CUE of whitefish and cisco, morphoedaphic index (MEI), percent clipped fish and adjusted CUE of stocked lake trout as selected parameters. The matrix is outlined in Table 6 with the parameter values detailed in Table 7. The CUE for stocked and native fish in Table 7 is for fish of the same year-class captured at age 2+, 3+, 4+ and 5+. The CUE for whitefish and cisco is for the total catch of lake whitefish, round whitefish and cisco combined. Conditions factors for age 2+, 3+ and 4+ lake trout were similar and the values presented are unweighted averages for these age groups.

It could be logically argued that the CUE values will vary from lake to lake depending on the number of fish per volume of water (assuming that the fish are distributed randomly). The adjusted CUE for stocked fish shown in the correlation matrix is an attempt to standardize the stocking rate on a volumetric basis. Weighting factors were derived by calculating the number of lake trout stocked per volume (10^4 m^3) of water and dividing the CUE of stocked lake trout by that number. In effect, we are stating that if stocking had been standardized by volume rather than by area, this is what the catch rate would have been. The CUE for stocked trout was highly correlated with the adjusted CUE for stocked trout ($r = .94$) indicating that stocking by area rather than volume did not introduce a bias.

The matrix suggests strong interrelationships among some of the fish species present in the lakes. These relationships may well have had an effect on stocking success and will be discussed in more detail later.

The stomach contents of lake trout were routinely examined in Peshu, Mount and Wawa lakes and cannibalism was noted in Peshu and Wawa. Predator trout were all age 4+ or older, and the lake trout which had been preyed upon ranged from 9.5 to 17 cm in size (probably age 1+). Four had adipose fin clips while the remaining 8 were too digested to accurately discern whether they were clipped or not. In total, 12 small trout were found in the stomachs of 316 large trout (>30 cm FL) examined throughout the study. However, 11 of the small trout were found in one year (1980) in Peshu Lake and were taken from a sample of 54 lake trout larger than 30 cm in fork length. These data indicate that cannibalism cannot be ruled out as a mechanism which may adversely affect stocking success.

DISCUSSION

Studies in New York State indicated that the strain of lake trout was more important than size in determining survival of stocked lake trout (Plosila 1977). MacLean et al. (1981) also suggested that lake trout strain may be an important factor in the survival of stocked fish. Little may be concluded concerning the effect of strain on survival rate from the present study, since only one strain of lake trout was used. There was, however, no attempt to match the physical and chemical characteristics of the donor lake to those of the recipient lakes. Lake Manitou, the source of lake trout for this study is a large, hard-water lake situated entirely on limestone rock. The fish were raised in a softwater hatchery and then stocked into softwater lakes on the Canadian Shield. In spite of these differences, the stocked trout survived well in some of the lakes and contributed substantially to the year-classes of the native populations.

Size of lake trout at stocking has been cited as a factor which may affect future survival of lake trout. Pycha and King (1967) suggested that a size of 17 to 20 lake trout lb^{-1} (22.7-26.7 g) was the optimum size for stocking in Lake Superior. The size of the lake trout stocked in the present study varied between 18.6 and 24.3 g and, over this size range, there was no apparent effect on survival. The largest fish (24.3 g) were stocked in 1980 and returns from this cohort were better than from other stockings in 2 of the lakes (Shakwa and South Anvil). Returns from the smaller fish (18.6 g in 1979 and 19.0 g in 1981) were better in 3 of the lakes (Mount, Rushbrook and Wawa). The remaining lakes had more or less equal returns from the year-classes stocked. It was generally felt, by district staff, that survival of smaller trout (<10 g) of the same strain had been poor in the past, however, no studies have been done to validate this concern.

Purych (1977) and MacLean et al. (1981) have suggested that a large native lake trout population in a lake will adversely affect stocking success. Cannibalism and competition for available resources were both cited as possible interactions between stocked and native fish. The correlation matrix (Table 6) also provides some evidence of negative interactions in the cold water communities of the 8

Table 5. Contribution of stocked fish to year-class strength.

Lake	Year-class	Number captured at age: 2+ S[1]	2+ N[2]	3+ S	3+ N	4+ S	4+ N	5+ S	5+ N	Total S	Total N	% S
Wawa	1976	0	0	0	0	0	0	1	1	1	1	50.0
	1978	3	4	10	16	0	4	1	0	14	24	36.8
	1979	1	7	1	25	1	6	0	0	3	38	7.3
	1980	16	9	10	14	0	0	0	0	26	23	53.1
	Total	20	20	21	55	1	10	2	1	44	86	33.9
North Anvil	1976	0	0	0	0	13	4	20	9	33	13	71.7
	1978	9	0	11	2	4	1	4	0	28	3	90.3
	1979	0	0	20	2	12	5	0	0	32	7	82.1
	1980	12	1	7	10	0	0	0	0	19	11	63.3
	Total	21	1	38	14	29	10	24	9	112	34	76.7
South Anvil	1976	0	0	0	0	0	0	8	1	8	1	88.9
	1978	7	1	8	4	0	0	1	0	16	5	76.2
	1979	7	0	21	2	8	1	0	0	36	3	92.3
	1980	4	1	1	2	0	0	0	0	5	3	62.5
	Total	18	2	30	8	8	1	9	1	65	12	84.4
Peshu	1976	0	0	0	0	1	56	0	8	1	64	1.5
	1978	3	5	8	4	0	29	0	4	11	42	20.8
	1979	6	18	8	17	2	15	0	0	16	50	24.2
	1980	3	12	9	17	0	0	0	0	12	29	29.3
	Total	12	35	25	38	3	100	0	12	40	185	17.8
Mount	1976	0	0	0	0	3	7	2	0	5	7	41.7
	1978	6	12	7	30	0	7	0	3	13	52	20.0
	1979	5	17	3	22	1	13	0	0	9	52	14.8
	1980	21	6	7	7	0	0	0	0	28	13	68.3
	Total	32	35	17	59	4	27	2	3	55	124	30.7
Shakwa	1976	0	0	0	0	9	1	1	0	10	1	90.9
	1978	6	3	5	0	0	0	1	0	12	3	80.0
	1979	49	0	49	2	12	3	0	0	110	5	95.7
	1980	10	5	21	1	0	0	0	0	31	6	83.8
	Total	65	8	75	3	21	4	2	0	163	15	91.6
Rush-brook	1976	0	0	0	0	0	5	0	3	0	8	0.0
	1978	2	0	3	0	0	0	1	0	6	0	100.0
	1979	9	0	2	0	0	0	0	0	11	0	100.0
	1980	20	6	13	5	0	0	0	0	33	11	75.0
	Total	31	6	18	5	0	5	1	3	50	19	72.5
Net	1978	0	0	0	0	0	12	0	1	0	13	0.0
	1979	0	0	0	37	0	9	0	0	0	46	0.0
	1980	1	9	0	19	0	0	0	0	1	28	3.5
	Total	1	9	0	56	0	21	0	1	1	87	1.2

[1]Stocked.
[2]Native.

Table 6. Correlation matrix for selected parameters on study lakes.

	CUE stocked trout	CUE native trout	CUE whitefish and cisco	Percent clipped fish	Condition factor	Morpho-edaphic index	Adjusted CUE stocked trout
CUE stocked trout (age 2-5)	1.00						
CUE native trout (age 2-5)	-.56	1.00					
CUE whitefish and cisco	-.57	.96**	1.00				
Percent clipped fish	.85**	-.75*	-.79*	1.00			
Condition factor	.61	-.79*	-.80**	.87**	1.00		
Morphoedaphic index (MEI)	-.52	.46	.61	-.54	-.27	1.00	
Adjusted CUE stocked trout	.94**	-.56	-.57	.76*	.55	-.52	1.00

* Significant at the 5% level.
** Significant at the 1% level.

Table 7. Parameter values for correlation matrix.

	Wawa	North Anvil	South Anvil	Peshu	Mount	Shakwa	Rush-brook	Net
Parameter								
CUE stocked trout (age 2-5)	0.56	2.24	1.41	0.34	0.65	2.63	0.74	0.08
CUE native trout (age 2-5)	1.09	0.68	0.26	1.57	1.48	0.24	0.28	7.25
CUE whitefish and cisco	25.05	16.60	15.50	18.45	24.30	11.38	8.28	52.76
Percent clipped fish	34	77	84	18	31	92	73	1
Condition factor	1.06	1.09	1.06	0.93	0.97	1.09	1.15	0.88
Morphoedaphic index (MEI)	6.8	2.9	2.6	1.6	6.4	2.4	3.8	6.1
Adjusted CUE stocked trout	0.66	1.25	0.78	0.50	0.37	2.04	0.45	0.05

study lakes. The sample size of 8 lakes is not large, however, and caution would be advised in using the relationships in a quantitative manner.

The correlation between the native lake trout CUE and the whitefish-cisco CUE (0.96) is significant at the 1% level, indicating that lakes which are favourable to natural lake trout populations are also favourable to whitefish and cisco. Where there are excellent populations of cisco, whitefish and lake trout there is competition for food. This is evident from the negative relationships between the condition factor and the CUE of native trout and the condition factor and the CUE of whitefish and cisco. The competition for food in these lakes may leave little room for stocked fish.

There is a negative (though not statistically significant) relationship between the CUE of stocked lake trout and the CUE of native lake trout, and between the CUE of stocked lake trout and the CUE of whitefish and cisco. Cannibalism as well as competition for food may play a role in the former relationship. Twelve lake trout were found in 316 lake trout stomachs in 3 lakes, and at least 4 of these were stocked fish.

In addition to interactions with the native fish communities, the method of stocking may have affected survival in the 8 lakes. The 3 lakes with the highest catch rates of stocked trout were all stocked by aircraft over deep water.

The subjective evaluation concerning the status of the native lake trout populations in the lakes was invalid based on the netting results. Shakwa and Rushbrook, which were felt to have excellent natural lake trout populations, held very few native trout. North Anvil and South Anvil which were originally evaluated as having fair populations had few native trout. These 4 lakes would seem to fit better into the poor category. Net Lake, which was classified as having a poor native population, had the best CUE for native trout and might be comparatively regarded as having an excellent native population. Peshu and Mount, which were

originally in the poor category and Wawa, which was classified as having a fair native population, all had intermediate CUE's of between 1.0 and 2.0 for native trout.

The present study emphasizes the importance of sound information on which to base experimental designs. The inclusion of lakes with different sizes of native lake trout populations came about largely by chance. Better planning and coordination of the many field workers over the 4 years of netting might have eliminated variables such as stocking methods and produced better information concerning cannibalism as a mechanism affecting the survival of stocked fish.

Although the initial experimental design could have been improved, some information has been gained concerning the survival of stocked lake trout. It is apparent that lake trout stocked in the 18 to 25 g size range can contribute significantly to the size of lake trout year-classes in many shield lakes. In lakes which have large native populations of lake trout and large populations of other cold water species such as whitefish and cisco, intense competition and cannibalism may result in poor survival of stocked fish. The study described here investigated the survival of stocked fish primarily in the younger age groups. No definitive conclusions can be drawn concerning the contributions that these fish may make to either the angler's creel or to future spawning stocks.

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